PB-216 383

WASTE DISPOSAL ASPECTS OF POTENTIAL PULP MILLS IN WESTERN COLORADO

H. R. Pahren, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

April 1960

DISTRIBUTED BY:

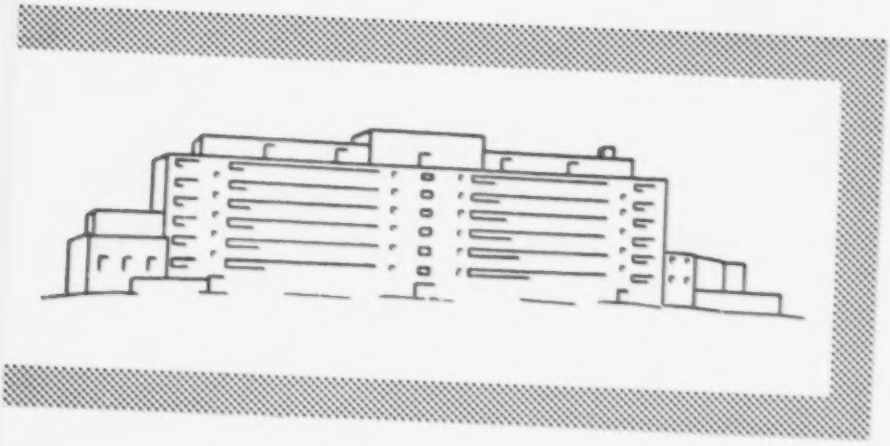
NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

LIBRARY
SANITARY ENGINEERING CENTER
CINCINNATI, OHIO

PB 216 38

WASTE DISPOSAL ASPECTS OF POTENTIAL PULP MILLS IN WESTERN COLORADO



The Robert A. Taft
Sanitary Engineering Center
TECHNICAL REPORT
W60-5

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U. S. DEPARTMENT OF HEALTH,
EDUCATION, AND WELFARE
Public Health Service

WASTE DISPOSAL ASPECTS OF POTENTIAL PULP MILLS IN WESTERN COLORADO

H. R. PAHREN AND W. W. TOWNE
Field Operations Section
Division of Water Supply and Pollution Control

With Assistance and Review by
Public Health Service, Region VIII Office
U. S. Department of the Interior, Forest Service
Colorado Department of Public Health
Colorado Department of Employment, Resources and Community Development
Colorado Game and Fish Department
Colorado Water Conservation Board

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

April, 1960

I

FOREWORD

This report presents an appraisal of pulp mill feasibility in certain selected areas of the Upper Colorado River Basin. It has been reviewed in draft form by the cooperating agencies, and the suggestions received have, for the most part, been incorporated in the report. Since some of the cooperating agency comments included supplementary information, and in one instance disagreement with a specific conclusion of the authors, these submissions are appended in full text.

Excellent cooperation by personnel in various Federal and Colorado agencies contributed greatly to the success of the survey and to the preparation of this report. Particular thanks are due Messrs. Kaarlo W. Nasi and Charles E. Sponagle of the U. S. Public Health Service Regional Office, Denver, Colorado; Mr. J. M. Hughes, U. S. Forest Service, Fort Collins, Colorado; Messrs. W. N. Gahr and G. A. Prince, Colorado Department of Public Health; Mr. D. E. Neill, Colorado Department of Employment, Resources and Community Development; Mr. L. L. Finley, Irrigation Engineer, Glenwood Springs, Colorado; and Mr. L. E. Riordan, Colorado Game and Fish Department. The assistance of these and all other individuals is gratefully appreciated.

Preceding page blank

CONTENTS

	Page
Foreword	iii
Summary and Conclusions	vi
Pollution Control Requirements	2
Scope of Investigations and Sources of Data	3
Wastes From Pulping Processes and Effects on Streams	4
Factors Pertinent to Consideration of Specific Pulp Mill Sites	6
Colorado River from Parshall to Kremmling	8
Colorado River from Sweetwater to Dotsero	9
Colorado River from New Castle to Rifle	9
Colorado River from Grand Junction to Fruita	10
Eagle River from Eagle to Gypsum	11
White River from Buford to Meeker	11
Gunnison River from Gunnison to Delta	11
North Fork of the Gunnison River from Somerset to Hotchkiss	12
Bibliography	13
Appendix	14

Preceding page blank

SUMMARY AND CONCLUSIONS

1. The Rocky Mountain Forest and Range Experiment Station of the U. S. Forest Service requested the U. S. Public Health Service to evaluate the water pollution aspects of several potential pulp mill sites as a part of a comprehensive study which the Forest Service is making of the opportunity for pulp mill development in western Colorado. This report presents an appraisal of the situation based on present available data. If a definite proposal for a mill develops, a more detailed study should be made for the specific area and agreement reached with the Colorado Department of Public Health concerning water pollution control features.

2. Eight locations were designated by the Forest Service for study. The four sites along the Colorado River are Parshall to Kremmling, Sweetwater to Dotsero, New Castle to Rifle, and Grand Junction to Fruita. Sites on smaller streams include the Eagle River between Eagle and Gypsum, the White River between Buford and Meeker, the Gunnison River from Gunnison to Delta, and the North Fork of the Gunnison River from Somerset to Hotchkiss. These areas were selected on the basis of several factors which include timber availability, transportation facilities, stream flows, water supply, suitable land, labor supply and waste disposal. It was not intended to exclude other sites if found to be more suitable.

3. State water pollution control laws and regulations of the Colorado Department of Public Health and the State Game and Fish Department would affect pulp mill waste discharges. The points considered most significant are that the wastes must not be detrimental to fish or spawning activities, setteable solids may not exceed 0.5 milliliter per liter, suspended solids may not exceed 75 parts per million, and 5-day, 20°C. biochemical oxygen demand may not exceed 50 parts per million. If the receiving stream is used downstream in Colorado as a surface source of public domestic water supply, the 5-day, 20°C. biochemical oxygen demand may not exceed 30 parts per million. All of the values mentioned refer to the mill effluent and not to the receiving stream.

4. The study brought out the lack of pertinent, basic water quality data for the rivers in Colorado. A comprehensive water quality study is needed to supply this necessary information.

5. Sulfate, neutral sulfite semichemical and groundwood processes were considered during the study. It was assumed that any mill would incorporate the latest plant designs and operating methods so as to minimize waste loads. Any departure from the assumed basis would require an upward or downward adjustment of maximum plant capacities indicated in this report.

6. Pulp mill wastes may do considerable harm to a receiving stream if waste control measures are not taken. Among the effects on the stream may be reduction of dissolved oxygen, toxicity, a fiber mat on the stream bottom, taste and odor, color, foaming, and Sphaerotilus growths.

7. To protect the stream and the waste treatment facilities, mills should have provisions for handling the wastes during a breakdown. In certain areas it may also be necessary to provide facilities for regulated discharge for protection of the stream from wastes during the low flow portion of a short cycle fluctuating stream flow resulting from power operations.

8. In selecting a suitable site for a pulp mill, the possibility of atmospheric odor nuisances should be recognized. Consideration should be given to the location of residential areas and to the factors that influence the strength and direction of travel of plant odors.

9. The following data concerning allowable mill capacities at the selected sites have been developed on the basis of the assumptions and limitations set forth in this report, and should be considered only in relation to this information:

   a. The Colorado River near Kremmling, Colorado can support a 350-ton sulfate

or a 60-ton neutral sulfite semichemical mill without seriously impairing the quality of water for other uses.

b. Near Dotsero, Colorado a pulp mill may be built with a maximum capacity of 600 tons per day if using the sulfate process or 110 tons per day if using the neutral sulfite semichemical process.

c. Between New Castle and Rifle, Colorado, a 500-ton sulfate plant or a 90-ton neutral sulfite semichemical plant may be constructed. These capacities take into account the possible shale oil developments in the future. Consideration must be given to the public water supplies at Rifle and DeBeque, Colorado.

d. Below Grand Junction, Colorado, basic data show that the Colorado River carries a relatively heavy waste load at present. The maximum plant capacity in this area would be 400 tons with the sulfate process or 75 tons with the neutral sulfite semichemical process. However, when the mills operate at these capacities, the dissolved oxygen in the river would be depressed to 4.0 parts per million.

e. At each of the potential pulp mill sites on the Colorado River, unbleached groundwood pulp mills of over 1000 tons capacity would be feasible. If bleaching operations are contemplated, a size limitation, if any, would depend on the degree of bleaching and processes used.

f. A 100-ton unbleached groundwood plant may be constructed on the Eagle River near Gypsum.

g. Between Buford and Meeker, Colorado, an unbleached groundwood pulp mill of 700 tons capacity may be supported by the White River. A bleaching operation would reduce this maximum capacity. Care must be taken that the public water supplies at Meeker and Rangely are not harmed.

h. Pulp mill sites along the Gunnison River from Gunnison to Delta, Colorado are not recommended, except in the immediate vicinity of Delta. At Delta a 600-ton-per-day unbleached groundwood plant may be built but the maximum capacity should be lower if bleaching is used.

i. Because of the construction of the Paonia Project, any mill on the North Fork on the Gunnison River should be located no further upstream than Hotchkiss. Near Hotchkiss, Colorado, a 700-ton unbleached groundwood plant could be supported by the assimilative capacity of the receiving stream.

Figure 1. POTENTIAL PULP MILL AREA

WASTE DISPOSAL ASPECTS OF POTENTIAL PULP MILLS IN WESTERN COLORADO

INTRODUCTION

The Rocky Mountain Forest and Range Experiment Station of the U. S. Forest Service has initiated a study to explore the opportunities for pulp mill development in western Colorado. It is expected that sufficient timber resources would be available in the area to support continuous operation of a pulping industry. An important part of such a study is concerned with the capacity of available dilution water to assimilate mill effluents without seriously impairing the quality of water for other uses. The Public Health Service has been requested by the Forest Service to assist in those portions of the over-all study related to water pollution.

This report presents an appraisal of the suitability of several site locations only from the water pollution standpoint. It should be emphasized that this is a preliminary study. Should a definite proposal develop for the construction of a pulp mill at a specific location, a more detailed study of the area would be necessary with consideration given to specific plant processes. In arriving at present conclusions, the best information that was readily available was utilized. It is recognized that there are many demands for the available water in the area and that sometimes there may not be sufficient water to satisfy all needs. In order to fulfill these needs, water is being stored when it is plentiful and released during periods of low flow. A number of these storage projects already exist and more are expected in the future. However, in the dynamic economy that exists there will be an increasing need for water in some areas while technological advances may reduce water requirements in other areas. In view of these circumstances, conclusions regarding pulp mill feasibility at a particular site at the present time may be altered considerably in the future.

It should be pointed out that responsibility for water availability and water pollution control in the area studied rests with the State of Colorado. Accordingly, final decisions in these matters should be made by the appropriate State agency.

There are a number of factors that influence the selection of potential mill sites. These include the location of available timber, transportation facilities, water supply, waste disposal, suitable land for the plant facilities, labor supply and stream flows. The areas considered in this study were designated by the Forest Service on the basis of the several factors involved. It is not intended to exclude other locations for the construction of a pulp mill. The sites selected are considered the best available at this time, but other sites may be found by interested parties to be more suitable.

Areas selected for study were:

Colorado River from Parshall to Kremmling
Colorado River from Sweetwater to Dotsero
Colorado River from New Castle to Rifle
Colorado River from Grand Junction to Fruita
Eagle River from Eagle to Gypsum
White River from Buford to Meeker
Gunnison River from Gunnison to Delta
North Fork Gunnison from Somerset to Hotchkiss

The Forest Service requested that the potential sites along the Colorado River be considered for groundwood, sulfate and semi-chemical pulping processes. Only the groundwood process was to be considered for the tributaries because of the limited assimilative capacity of these streams. A map showing the area is presented in Figure 1.

POLLUTION CONTROL REQUIREMENTS

The state agency having the primary responsibility for water pollution control is the Colorado Department of Public Health. This Department was given the authority to establish regulations concerning sewage and industrial wastes. Accordingly, the following regulations were established governing the effluents of sewerage systems and industrial wastes discharged upon the land or into the surface or ground waters. (1)

"1. The following definitions shall apply to terms used in these regulations:

   a. Effluent of sewerage systems means any liquid containing toxic substances or suspended, floating, or dissolved matter discharged upon the land or into the surface or ground waters.

   b. Trade wastes mean any liquid containing toxic substances or suspended, floating, or dissolved matter originating from industrial processes as distinct from domestic or sanitary sewage and discharged upon the land or into the surface or ground waters.

   c. Matter means chemical substances of animal or vegetable origin.

   d. Discharged upon the land is not to considered as applying to land used as part of a special disposal process for the purpose of eliminating trade wastes and effluents from sewerage systems.

2. The effluent of sewerage systems or trade wastes shall not contain substances in quantities toxic to man.

3. No floating matter shall be discharged in the effluent of sewerage systems or trade wastes.

4. The effluent of sewerage systems and trade wastes shall not contain settleable matter exceeding five-tenths (0.5) milliliter per liter.

5. The effluent of sewerage systems and trade wastes shall not contain suspended matter exceeding seventy-five (75) parts per million.

6. That portion of domestic sewage or industrial waste that is dissolved or suspended in the effluent of sewerage systems or trade wastes shall not exceed fifty (50) parts per million when measured in terms of five-day, twenty-degree-centigrade, biochemical oxygen demand (5-day, 20°C. BOD) in any case. However, if the effluents of sewerage systems or trade wastes are discharged into a watercourse used downstream in Colorado as a surface source of public domestic water supply, the dissolved or suspended matter shall not exceed thirty (30) parts per million when measured in terms of five-day twenty-degree-centigrade, biochemical oxygen demand.

7. Methods used in determining compliance with these standards shall be in accordance with Standard Methods for the Examination of Water, Sewage, and Industrial Wastes, 10th Edition. Such determinations shall be based on the average of results during the period under study and in all cases shall consist of at least four (4) samples taken at intervals of at least one hour."

In addition to these regulations a municipal council is empowered by State law - Chapter 139-32-1 (35) C. R. S. 53 - to pass an ordinance that would prohibit discharge of polluting materials within five miles upstream of a municipal water intake. This action may be taken only where the municipality has constructed a water works outside the city limits.

The Colorado Game and Fish Commission administers laws which pertain to the aquatic life in the State streams. Citations taken from these laws are quoted:

"No sawdust, tailings, or other deleterious or poisonous substances may be allowed to run or pass into or pollute any public waters containing fish, or deposited or left where it may be carried by natural causes into such waters, in such quantities as to destroy or be detrimental to the fish or spawn therein." (Chapter 62-5-13)

"Every dam or other artifical obstruction, every placer mine, mill, reduction plant or other industrial enterprise, constructed, maintained or operated in violation of the Act is declared unlawful and a continuing public nuisance and the same may be enjoined or abated or its objectionable features modified." (Chapter 62-5-12)

"Whenever such an obstruction of pollution is alleged to exist, the Commission, any citizen or the owner or operator of such obstruction or industry may file a petition in the District Court of the county wherein the obstruction or pollution exists for the purpose of having an equitable determination of the fact and a temporary injunction may issue upon notice, if the fact of obstruction or pollution is evident and the necessity is urgent." (Chapter 62-5-15)

"The court determines the issues having due regard to the public welfare. It may order the adoption by the owner or operator of such means as may be reasonable and practicable to prevent or lessen the injurious effect upon the fish and their propagation; or may abate the obstruction, or perpetually enjoin the operations which cause the injury, or render such other judgment as the rights of the case may require. In making its determination the court is not precluded from considering the other beneficial uses to which such waters are or may be applied." (Chapter 62-5-18)(2)

The Federal Water Pollution Control Act, Public Law 660, 84th Congress, provides authority for the U. S. Public Health Service to take the necessary enforcement measures against pollution of interstate waters, where such pollution endangers the health or welfare of persons in a State other than the one in which the discharge of pollution originates.

Of the pulp mill sites being studied, the only one which may possibly impair the quality of water in a State other than Colorado would be the site below Grand Junction. However, if the effluent requirements of the State of Colorado are met, the possibility of a pulp mill near Grand Junction having a deleterious effect on the waters of Utah is remote.

An effluent standard rather than a stream standard is used for regulating the load which may be discharged to a receiving stream. If a pulp mill dilutes its process with plant cooling water, the concentration of pollutional constituents flowing to the stream would be reduced. The quantity of pollutional constituents would not, however, be reduced.

The Colorado Department of Public Health has indicated that in the case where a public domestic water supply is taken from the main stem of the Colorado River, the 30 p. p. m. 5-day, 20°C. BOD effluent regulation would apply to all discharges, into the main stem and tributaries, above the water supply, even though there are no water supplies taken from the tributary itself. Therefore, the 30 p. p. m. 5-day, 20°C. BOD would apply to pulp mill discharges at all eight potential sites being studied.

It is not the purpose of this report to specify treatment measures which should be practiced. Rather, it is the purpose to summarize the available information pertaining to the water pollution aspects of pulp mills and to indicate the feasibility and limiting conditions of mill installations.

SCOPE OF INVESTIGATIONS AND SOURCES OF DATA

During August 1959, an inspection of the Colorado River from Hot Sulphur Springs to Loma was made by the senior author in company with personnel of the U. S. Forest Service, Colorado Department of Public Health and Colorado Department of Employment, Resources and Community Development Division. In addition, the Eagle River site was inspected. The sites on the Gunnison, North Fork Gunnison and White Rivers were not inspected personally but the analysis for these sites were based on available data pertinent to the study.

The Bureau of Reclamation Office at Denver provided information concerning present and proposed water resources development which may affect stream characteristics.

Considerable information concerning the legal aspects of waste discharges to State streams was furnished by the Colorado Department of Public Health. This Department also provided data on municipal waste loads and existing water supplies.

The State Irrigation Engineer at Glenwood Springs, Colorado described the reservoir operations and diversions which affect flows on the Colorado River and provided data on time of water travel between different points.

Basic data on past flows were obtained from U. S. Geological Survey records. These records were used to appraise the minimum dilution that would be available for waste discharges.

Dr. J. M. Morgan, Jr., provided valuable data[3] which he collected during the summer of 1958 for portions of the Gunnison and Colorado Rivers. His thesis is one of the few sources of information containing background dissolved oxygen and biochemical oxygen demand values that may be expected in the rivers.

Discussions were held with personnel from the Institute of Paper Chemistry, Appleton, Wisconsin to confirm the waste loads expected from pulp mills.

The Division of Resources and Community Development of the Colorado Department of Employment gathered much information about the shale oil development in Colorado. Probable pollutional effects from this industry along with water needs were discussed.

A meeting was held with the Colorado Game and Fish Department in Denver. Information was obtained on the types of fish life in the streams being studied, the oxygen requirements, and the fish planted in different streams.

Much pertinent data were obtained from the files of the Public Health Service Region VIII Office, the U. S. Forest Service and the Robert A. Taft Sanitary Engineering Center of the Public Health Service. This information was used to assist in the evaluation of the over-all problem.

In spite of the amount of information that was available, the study revealed a definite lack of pertinent basic water quality data for the rivers in Colorado. Engineering judgment had to be used in many cases instead of actual results. It is hoped that many of these gaps in information might be filled in by future comprehensive water quality studies.

WASTES FROM PULPING PROCESSES AND EFFECTS ON STREAMS

Waste loads from a kraft or sulfate pulp and paper mill can vary considerably depending on the design and operation of the plant. Many basic waste control measures may be designed into a plant and with proper operation the waste loads in the plant effluent may be minimized. Typical waste loads from a modern kraft pulp and paper mill practicing "standard" in-plant waste control measures are given in Table 1. In this table, wastes with a biochemical oxygen demand greater than 250 parts per million are considered strong wastes, while those with a biochemical oxygen demand below 250 parts per million are listed as weak wastes. It was assumed in Table 1 that a hydraulic debarking operation would not be used.

If a bleaching operation is not used or if the product is shipped out as pulp rather than being processed into paper, then the wastes in the plant effluent would be less. Some modern plants have practiced re-use of condensates and other waste streams and thus "bottled up" a large portion of the waste load from the plant. If a plant is designed to eliminate some of the process waste streams from the plant effluent, then appropriate deductions may be made for estimating the waste load. Conversely, if a plant practices less than the "standard" in-plant waste control measures an added waste load will result. A waste load of 50 pounds of 5-day 20°C. BOD per ton of pulp was used in the calculation for the sulfate process.

A well-designed and operated unbleached groundwood pulp and paper plant would be expected to produce an effluent containing 3 to 10 pounds of 5-day BOD per ton of pulp. Water use ranges from 4,000 to 16,000 gallons per ton of pulp. Groundwood pulp is sometimes given hydrosulfite bleaching and this operation could add to the waste load.

Low yield neutral sulfite semichemical plants produce an effluent containing approximately 275 pounds of 5-day BOD per ton of pulp if there is no chemical recovery. With chemical recovery the BOD load could be reduced about 50 to 90 percent. Many neutral sulfite semichemical plants are integrated with kraft plants. When it is possible to send all semichemical black liquor to the kraft recovery system, a

TABLE 1. TYPICAL WASTE LOADS FROM A MODERN KRAFT PULP AND PAPER MILL

Type of waste	Volume, gal./ton pulp	5-Day BOD, lbs./ton pulp
Strong Wastes:		
Log haul-up spray water	250	0.6
Turpentine separator waste	35	2.0
Excess blow tank condensate and condensing water	1,000	3.2
Condensate from steam chests of the black liquor evaporators	870	5.1
Total	2,155	10.9
Weak Wastes:		
Condenser water of black liquor evaporators	13,000	6.0
Waste from pulp screening and paper machines	4,800	7.2
Water from bleaching operations	40,000	25.0
Total	57,800	38.2

considerable portion of the pollution load may be eliminated. A number of separate recovery systems for neutral sulfite semichemical processes are in various stages of development. Seven different processes have been studied, namely, the Mead, Institute, Zimmerman, Sivola, Atomized Suspension, Western Precipitation, and the Stora-Kopparberg Process. Some of these processes are in operation in a few mills.

Toxicity is sometime mentioned in connection with the wastes from some chemical pulping processes. However, it is now generally recognized that critical depletion of dissolved oxygen in the receiving waters is the controlling parameter, as this occurs at waste concentrations less than the threshold levels required to prevent toxicity to aquatic life. This is particularly true of modern mills which are designed to recover more of the process chemicals and to reduce the discharge of potentially toxic materials.

The oxygen demand of pulp mill wastes tends to reduce the dissolved oxygen content of the streams receiving the wastes. If the demand is too great, the residual oxygen may be depressed to such an extent that the aquatic life in the streams may not survive. Fish may still be harmed when the oxygen concentrations are slightly above lethal levels by being unable to propagate, swim against currents or to carry out other normal life functions.

A very small daily loss of fiber from a pulp and paper mill may result in an extensive accumulation of fiber with time on the bottom of a receiving stream. This is especially true with a slow moving river or a fairly quiescent area such as a reservoir. This mat of fiber smothers the aquatic organisms on which fish feed and undergoes slow decomposition which contributes to the benthal or stream bottom oxygen demand.

Pulp mill wastes may result in a taste and odor problem at downstream water supplies under certain conditions. However, some of the more potent taste and odor producing substances would be unstable under aerobic stream conditions and would disappear rapidly. If the wastes receive adequate treatment and dilution, and if downstream water supplies are sufficiently distant, it is expected that taste and odors would be below threshold levels at the point of water intake. At the treatment and dilution contemplated for the wastes, there should also be no problem when using the receiving stream for irrigation.

Pulp mill wastes sometimes cause foaming and color in receiving streams. Color is particularly intense in kraft and semichemical wastes. It is difficult to reduce color by any simple means and the most feasible solution is adequate dilution so that the color does not exceed 20 (platinum-cobalt scale) at any downstream water supplies.

Sphaerotilus in streams below pulp mill discharges has become an important problem during the past few years. These long, plumose growths are found attached to rocks or other fixed objects and are stimulated by certain wastes, including pulp mill discharges. The growths break loose and float downstream. It is very possible that recreational use of some areas downstream of mill discharge may be limited because of these slimes. In addition to the possibility of fouling of fishing gear, the settling of Sphaerotilus flocs at the beginning of reservoir backwaters may also cause sludge deposits which may create a problem. Pollution of a stream used as a water supply, by Sphaerotilus, may cause severe clogging of rapid sand filters and necessitate frequent backwashing of the filters.

FACTORS PERTINENT TO CONSIDERATION OF SPECIFIC PULP MILL SITES

The general area selected for potential pulp mill sites is located on the western slope of the Rocky Mountains, not far from the Continental Divide. Great expanses of flat land are not generally available. At most of the sites examined, relatively flat land was available near the river but fairly steep mountain slopes were not too far distant.

At the relatively high elevation of the area the reduced atmospheric pressure has a significant effect on the saturation value for dissolved oxygen in water. The oxygen saturation value is lower than at sea level so that less oxygen is available for stabilizing waste discharges.

Slopes of the river beds are fairly steep. This causes many riffles and much river turbulence with the result that good reaeration characteristics exist. The slopes tend to be greater at the higher elevations.

At all sites, consideration should be given to having sufficient land area available for storage so that in case of a process breakdown it would not be necessary to discharge slugs of strong wastes directly to the receiving stream or to interfere with the normal method of waste treatment.

Generally, the lowest stream flows at the points where potential pulp mills would discharge wastes would be during the winter months. Comparisons using the winter conditions of low stream temperatures and low flows to the late summer conditions of high stream temperatures and moderate flows show that waste discharges would cause the lowest dissolved oxygen conditions in the river during the late summer period. Accordingly, a statistical evaluation was made of the return flows to be expected during the most critical month. In most cases, the critical month, or the month when the dissolved oxygen in the river below the mill site would be expected to reach the lowest level, is August.

In calculating the effects of wastes upon a stream, it is necessary to know the amount of dilution water that will be available. The minimum flow of record is not necessarily the proper figure to use because of the temperature-oxygen relationships. After considering several aspects of the problem it was judged best to base calculations for the dilution water available on the average flow during the lowest seven-consecutive-day period of the critical month that would be expected to occur once in 10 years. Thus, if at a particular site August was found to be the critical month, the lowest 7-day period was found for the month of August for each year of record. Using these values for each year in a statistical analysis, the low 7-consecutive-day period during the month of August that may be expected once in 10 years

was determined. Obviously, flows less than this calculated value would occur not only during the cooler months of the year but also on individual days of the critical month.

During the determination of expected low flows on the Colorado River only the values for the last 10 years of record were used, because diversions to the east slope of the mountains and reservoirs which have been completed recently have changed the river flow characteristics. For the four potential sites not on the Colorado River, all available records within the past 20 years were used.

The legal requirements in Colorado do not include a value for the minimum permissible dissolved oxygen in a stream receiving wastes. Therefore, a pulp mill theoretically could discharge a sufficient quantity of wastes that the entire oxygen resources of the stream would be consumed; yet the parts per million of BOD in the wastes from the mill may be well within the effluent standard. With such a condition there would be serious effects upon the aquatic life, so that the laws administered by the Colorado Game and Fish Department would apply. Thus, for purposes of this study a minimum dissolved oxygen value must be assumed for the stream. The maximum quantity of wastes which may be discharged, from the standpoint of biochemical oxygen demand, would be that amount which would result in the oxygen concentration in the stream being depressed to the assumed minimum value.

For all potential pulp mill sites being evaluated except the one below Grand Junction the minimum allowable dissolved oxygen which was assumed was 5.0 p. p. m. This concentration of oxygen is needed to prevent damage to the aquatic life of the area. For the stretch of the Colorado River below Grand Junction the minimum allowable dissolved oxygen assumed was reduced to 4.0 p. p. m. because the requirements for the type of aquatic life found in the area are less.

The objective is to maintain a satisfactory stream water quality at all times for all legitimate water uses, such as domestic and industrial water supplies, irrigation, aquatic life propagation and stock watering. In general, if there is sufficient dilution available for the wastes from a properly designed and operated modern pulp mill so that an adequate supply of oxygen is always present in the receiving stream for aquatic life propagation, it is considered that the water quality would be suitable for other water uses. The only apparent exception may be a taste and odor problem at a drinking water supply which may be a short distance downstream. With a modern kraft mill the oxygen consideration would be more critical than the toxicity factor in the receiving stream.

The pulp mill capacity which may be constructed at a particular site depends to a considerable extent on the waste treatment facilities in operation at the plant. If a mill removes a large amount of the pollution constituents in the wastes, a larger plant could be built than where the wastes are not treated. This statement assumes that the State effluent regulations are fulfilled in each design.

In order to meet the Colorado effluent regulations it is expected that most pulp mills would require treatment of their wastes or sufficient dilution of the process water with another flow, such as plant cooling water. Since water would be relatively scarce, it is expected that a large quantity of dilution water would be difficult to obtain. However, water consumption would also be a consideration in determining the amount of water a mill may obtain.

If it were possible to have 100 percent consumption of the water obtained by a mill, that is, by having land disposal of the wastes instead of returning the liquids to the stream, then there would be no particular size limit to the mill. In such a case there must be no damage to underground water uses.

In approaching the problem of estimating the mill capacity which could be supported by the receiving stream from the standpoint of water pollution, it was considered best to present the maximum quantity of BOD which may be discharged by the mill to the receiving stream. This amount of BOD should not be exceeded, especially during the late summer and early fall months. An approximation of the mill capacity associated with the stated maximum quantity of biochemical oxygen demand will also be given. It is recognized that this maximum mill capacity could vary, depending on the process design, waste treatment measures, changes in dilution water available and several other factors. A mill may even

use two different pulping processes and integrate certain common steps. Therefore, if a firm proposition is obtained to construct a new pulp mill, it would be advisable to re-evaluate the stream pollution question in light of the specific waste control measures and processes planned by the mill.

In one or two areas, the maximum waste load that could be discharged by a pulp mill without having adverse effects on the receiving stream could be increased if the local municipalities would install sewage treatment. Present State law requires a fairly high degree of treatment for sewage, but not all municipalities have installed the necessary treatment.

The minimum economical size of a chemical pulp mill is dependent upon such factors as the availability, quality and cost of raw materials, the proximity of markets, and the type of product. A chemical pulp mill which obtains low-cost, high-quality wood, is close to markets, and manufactures a speciality pulp might be operated economically with an output as low as 100 tons per day. (4) However, a mill producing kraft pulp for wrappings or paperboard, which are more highly competitive and cheaper products, would need to be much larger in order to utilize larger and more efficient equipment, unless there are site factors which would compensate for the higher unit production cost of a smaller and less efficient mill. Normally, such a mill would have a minimum daily production of about 300 tons.

The smallest economic size for semichemical and groundwood pulp mill is approximately 50 tons per day. For best results, semichemical and groundwood pulps should not be permitted to dry before being used for making paper, therefore pulp mills using these processes are usually integrated with paper mills.

When sites are fairly close together, it would not be advisable to construct pulp mills of size near the estimated maximum capacity at both of these sites, as the receiving streams may not be able to assimilate wastes from both mills. A possible example would be mills on the Colorado River at both Dotsero and New Castle, or a mill on the Eagle River and also one on the Colorado River at Dotsero. However, small mills of much less than maximum capacity indicated may be feasible.

More detailed considerations concerning the evaluation of pulp mill sites are discussed for each specific site.

Colorado River From Parshall to Kremmling

August is the critical month for the Colorado River near Kremmling. The lowest seven-consecutive-day average flow expected once in 10 years during August is 475 cubic feet per second at this point. This flow includes that added by the Blue River at Kremmling.

Mr. L. L. Finley, the State irrigation engineer at Glenwood Springs advised that above the confluence with Williams Fork River an ice cover can be expected on the Colorado during very cold periods. However, he stated that below this point a complete ice cover is not expected with peaking power daily flow fluctuations from the reservoirs. Williams Fork Reservoir was constructed to help maintain certain minimum flows in the Colorado River and releases would not be reduced on weekends, even if it is necessary to bypass the power plant.

If the wastes discharged to the Colorado River are in such quantities that the river is affected during the low-flow portion of the peaking power cycle, the mill may coordinate its discharge with the flow schedule to maintain water quality. Limited storage facilities would be necessary.

Kremmling is at an elevation of 7300 feet. At the reduced pressure existing at this elevation and at 20°C., the approximate maximum water temperature during the summer, the dissolved oxygen at its saturation value is 6. 85 p. p. m.

The reaeration characteristics of the Colorado River below Kremmling are very good. With a slope of the river bed of about 20 feet per mile there are many riffles and much turbulence.

Water available for diluting any pulp mill discharge is expected to contain very little organic matter, with the result that the biochemical oxygen demand would be low. The dissolved oxygen of this water is expected to be near saturation. Even though the dilution water has been taken from the lower part

(hypolimnion) of upstream reservoirs, where it is not uncommon for the dissolved oxygen to be low, it is anticipated that the large stream slope downstream from the dam will result in nearly saturated conditions at the pulp mill site.

A waste discharge of 17,500 pounds of 5-day, 20°C., biochemical oxygen demand per day would be the maximum amount that may be discharged to the Colorado River between Parshall and Kremmling without seriously impairing the quality of water for other uses. This load would be equivalent to a 350-ton sulfate plant or a 6-ton semichemical plant. A groundwood pulp plant of over 1000 tons capacity would be feasible provided there is no bleaching. If bleaching is contemplated, any capacity limitation would be governed by processes and degree of bleaching.

Colorado River from Sweetwater to Dotsero

August was found to be the critical month for waste discharges into the Colorado River at Dotsero, Colorado. The low seven-day flow during August that would be expected once in 10 years was found to be 950 cubic feet per second at the Dotsero gaging station.

About five miles below Dotsero the backwater behind the Shoshone Dam begins. The backwater extends about 4.0 miles behind the dam. During low flows the entire flow of the Colorado River is diverted through a tunnel to the Shoshone power plant, located 2.5 miles below the dam site. From the power plant tailrace to Glenwood Springs, the river is continuous riffle and fast moving. At Glenwood Springs considerable dilution is provided by Roaring Fork.

The reaeration characteristics in the backwater behind Shoshone Dam would be very poor. However, the detention time under low flow conditions was calculated to be 0.26 day, so that the effects of the reservoir would not be too serious. Any fiber lost from a mill would undoubtedly settle out in the reservoir. Below Glenwood Springs the river slope averages 13 feet per mile, so that good reaeration may be expected.

Temperatures would be expected to increase during August as the river flows downstream. Water temperatures of 22°C. may be expected near Dotsero, while 24°C. is likely below Glenwood Springs.

While the amount of organic matter in the river near Dotsero is expected to be greater than that existing near Kremmling, it would not present a problem. The mineral content of the water is much higher at the downstream locations, from the large amount of irrigation return water and leaching of soil minerals.

In the area along the Colorado River near Dotsero, Colorado, the maximum 5-day, 20°C. BOD that may be safely discharged by a pulp mill would be 30,000 pounds per day. Therefore, the river at this point would support a 600-ton-per-day sulfate mill or a 110-ton neutral sulfite semichemical mill. There would be no size limitation for a groundwood plant within a capacity range believed to be contemplated, if the pulp does not receive a high degree of bleaching.

Colorado River from New Castle to Rifle

The dilution available for waste discharges at the New Castle to Riffle stretch of the Colorado River during the critical month of August was found to be 1300 cubic feet per second for the lowest seven-day flow expected once in 10 years. During periods of low flow and peak irrigation demand practically all of the flow in the Colorado River is diverted near Cameo for irrigation use.

The backwater behind the diversion dam extends 1.2 miles. Any fiber loss from a pulp mill may be expected to settle out in the quiescent backwater.

The Bureau of Reclamation lists two potential developments near the area under study. A definite plant report is in process for the Silt Project which would supply additional irrigation water. The dam for the Silt Project would be located on Rifle Creek about 3.5 miles from the Colorado River. This project is expected to have little effect on a pulp mill.

Debeque Reservoir has been proposed for the Colorado River. The dam for this project would be located at Grand Valley, Colorado and back up water past Rifle. If built, this reservoir would have considerable effect on the assimilative characteristics of the river. However, Mr. Johnson of the Bureau of Reclamation Office in Denver stated that there is only a very remote possibility of this reservoir being constructed.

In the area near Rifle, the potentially large shale oil development is located. A recent report[5] prepared by the firm of Cameron and Jones for the Colorado Water Conservation Board presents much information regarding the probable water requirements for production, related industry, domestic use and other probable industrial use not directly related to the shale oil industry. It is estimated that by 1975 there will be a total new population of 340,000 for production and supporting services. A water supply of 252,000 acre feet per year, with 159,000 acre feet consumed, would be required to meet the industrial and domestic needs.

It is expected that the proposed Ruedi Reservoir, located on Fryingpan River east of Glenwood Springs, Colorado, would supply the water necessary to meet the requirements of the shale oil development. This multiple purpose reservoir is currently under study by the Bureau of Reclamation.

Rifle and Debequ. take their public water supplies from the Colorado River. With a pulp mill located just a short distance above these water supplies, water quality complications would easily arise. Even if the State regulations are met for the pulp mill effluent, it may be necessary for the mill to institute a higher degree of waste treatment, pipe the wastes below the public water intake, or to pay the expense of relocating the water supply.

The Colorado River between New Castle and Rifle can assimilate a 5-day, 20°C. BOD load of 32,000 pounds per day under present use conditions. This would be equivalent to a 650-ton sulfite mill or a 115-ton neutral sulfite semichemical mill. There would be no particular size limitation for a groundwood mill within a capacity range believed to be contemplated.

If river assimilative capacity is reserved for the shale oil development, and assuming the domestic and industrial wastes from this potential development receive secondary treatment, only 25,000 pounds 5-day, 20°C. biochemical oxygen demand would be the maximum permitted from a pulp mill. This would limit the size of a sulfate mill to 500 tons per day and a semichemical mill to 90 tons per day.

Colorado River from Grand Junction to Fruita

The Gunnison River enters the Colorado River at Grand Junction. Between Grand Junction and Fruita a considerable number of ditches return irrigation water to the Colorado. The only flow gaging station that measures the effect of all these flows is located near the Colorado-Utah border. Since the river flow does not change significantly between Fruita and the Utah border, the records from the gaging station are considered satisfactory. Records at the border gaging station are available only from May, 1951 to the present; therefore, it was necessary to approximate the Colorado River flow during 1949 and 1950 by subtracting the flow of the Delores River from the Colorado River flow at Cisco, Utah.

Again, August was found to be the critical month. The lowest seven-consecutive-day flow that is expected once in 10 years during the month of August was found to be 1000 cubic feet per second at the Utah border. The area below Grand Junction is normally very warm and water temperatures of 25°C. are expected. The saturation value of dissolved oxygen at this temperature and at the elevation of the area is 7.05 p. p. m.

Available summer water quality data below Grand Junction indicate that the biochemical oxygen demand is about 4.0 p. p. m., and that the dissolved oxygen is 5.5 p. p. m. and sometimes lower.

A gilsonite plant is located near Fruita, Colorado. This plant uses water from the Colorado River for industrial and domestic purposes. The Colorado Department of Public Health advised that this is considered a public domestic water supply, and consequently the 30 p. p. m., BOD effluent standard would apply for upstream waste discharges. The Colorado Game and Fish Department stated that no trout are found below Grand Junction, but that channel catfish is the principal type of fish present. Channel catfish do not require as much oxygen as a number of other fish; therefore, the minimum allowable dissolved oxygen used in the calculations for the area below Grand Junction was 4.0 p. p. m.

The maximum size pulp mill that could be constructed below Grand Junction depends on the minimum dissolved oxygen permitted in the river. If the dissolved oxygen may not be

reduced below 5.0 p.p.m., the minimum economical size chemical or semichemical mill could not be built. As discussed previously, a minimum dissolved oxygen value below Grand Junction of 4.0 p.p.m. was used in the calculations. At this level, the maximum discharge of 5-day, 20°C. biochemical oxygen demand from a pulp mill would be 20,000 pounds per day. Plant capacities at this level of discharge would be 400 tons per day for a sulfate mill and 75 tons per day for a neutral sulfite semichemical mill. An unbleached groundwood pulp mill of over 1000 tons capacity would be feasible. A limitation for a groundwood mill producing a bleached pulp would depend on the degree of bleaching and the wastes expected from these additional processes.

Eagle River from Eagle to Gypsum

Much of the area between Eagle and Gypsum is irrigated and the gaging station below Gypsum reflects this irrigation return water. The low seven-day-flow during August which is expected once in 10 years is 140 cubic feet per second. During low flows the mineral content of the Eagle River exceeds desirable limits for domestic and many industrial purposes. The stream drains an area consisting of soils which have been largely derived from erodible sandstones, shales and limestones, with sandstone formations predominating. These formations are apparently responsible for the high mineral content of the water.

The Eagle River freezes over during some winter periods. However, the dissolved oxygen in the cold water flowing beneath the ice would be relatively high, and with only about 3.0 days time of water travel from the potential mill site to the Colorado River, a pollution problem in the winter is not anticipated.

At the expected summer temperature of 23°C. and at 6200 feet elevation, the dissolved oxygen saturation value would be only 6.8 p.p.m. The Eagle River above the potential plant site has a fairly steep slope with many riffles and should be saturated with oxygen. The stream slope below Gypsum, although less steep than above, would still have fairly good reaeration characteristics.

The Eagle River is greatly diluted when discharged to the Colorado River. Therefore, as long as the Eagle River is kept relatively unpolluted, dilution will take care of downstream conditions. The maximum quantity of 5-day, 20°C. BOD that may be safely assimilated by the Eagle River is 7,500 pounds. A 1,000-ton unbleached groundwood pulp mill could be constructed here. If bleaching is contemplated, the capacity limitation would be governed by the degree of bleaching.

White River From Buford to Meeker

Analysis of flow records over the past 20 years for the White River at Meeker indicates that 210 cubic feet per second may be expected once in 10 years during the low seven-consecutive-day period of August. Even with a complete ice cover on the river, winter conditions would not be controlling.

Public water supplies are taken from the White River at both Meeker and Rangely, Colorado. Although Rangely is located a considerable distance downstream, Meeker is within the river stretch being studied.

A considerable area near Meeker is under irrigation. While the diversions for the area are taken above the gaging station, part of the return flow enters the river below.

At the elevation of Meeker and the expected maximum water temperature of 24°C. the dissolved oxygen at saturation is 6.6 p.p.m. Between Buford and Meeker the river has a slope of 29 feet per mile which would tend to indicate that the water would be saturated at a mill site in the area. From Meeker to Watson, Utah the White River averages 16 feet per mile slope, which still would provide good reaeration.

A groundwood mill could discharge only 3,500 pounds of 5-day, 20°C. biochemical oxygen demand without unduly affecting water quality in the White River. This would permit an unbleached pulp capacity of 700 tons per day for a well designed and operated plant. If the mill bleaches any of its pulp, the maximum plant capacity would be reduced accordingly.

Gunnison River From Gunnison to Delta

The Curecanti Unit of the Bureau of Reclamation's Colorado River Storage Project has been authorized for construction. The final plan may call for 2 or 3 dams in the reach

of the Gunnison River between the Black Canyon of the Gunnison National Monument and the City of Gunnison, Colorado. Most of the available mill sites would probably be inundated by the construction of these multiple-purpose reservoirs. In addition, if a large amount of wastes are discharged directly to a reservoir a severe pollution problem may result. Therefore, it is recommended that the area where the Curecanti Unit is to be located not be considered for a pulp mill site at the present time. Perhaps when the specific locations of the reservoirs and the available flows are determined, it may be possible to reevaluate this particular area to ascertain the feasibility of a small groundwood plant.

The only feasible location for a pulp mill at the present time between Gunnison and Delta, Colorado, would seem to be in the immediate vicinity of Delta. Flow at Delta would be the sum of the flows of the North Fork of the Gunnison, Uncompahgre and the Gunnison above its confluence with the North Fork of the Gunnison. Much of the flow in the Gunnison River is diverted to the Uncompahgre River Valley for irrigation, and during low flow periods of late August or September the Gunnison River below the Black Canyon of the Gunnison may dry up completely.

Expected low seven-day flow occurring during August once in 10 years, in the Gunnison River below the confluence with the Uncompahgre, is 200 cubic feet per second. If the Curecanti Unit provides considerable low flow augmentation after it is constructed, then the low flow figure may be increased accordingly. Increased August flows in the future due to the Paonia Project on the North Fork of the Gunnison have been taken into account.

The area between Delta and Grand Junction is hot and desolate. Slope of the river bed averages eight feet per mile and the water would tend to be less turbulent than some of the other streams evaluated having greater slopes.

A maximum of 30, 000 pounds of 5-day, 20°C. BOD may be safely discharged to the Gunnison River at Delta by a pulp mill. For a well designed and operated plant this load could be expected from a groundwood mill producing 600 tons per day of unbleached pulp. This capacity would be reduced if the pulp is bleached, depending on the processes and degree of bleaching. If the town of Delta installed secondary sewage treatment and if this reduction on organic load were taken up by the pulp mill, the mill capacity could be increased to 700 tons per day of unbleached pulp.

North Fork of the Gunnison River From Somerset to Hotchkiss

Calculations based on available flow records on the North Fork of the Gunnison indicate that the lowest seven-consecutive day flow expected once in ten years during the critical month of August would be 62 cubic feet per second. However, after full development of the Paonia Project the Bureau of Reclamation estimates(6) that the flows of the North Fork of the Gunnison at the mouth will increase an average of 25 cubic feet per second during August, September and October. Water will be stored during the spring flood flows and released for irrigation during the summer. Winter flows in the river will remain unchanged. With the additional 25 cubic feet per second flow, the low seven-day August flow would be 87 cubic feet per second at the mouth.

It should be pointed out that the return irrigation water will be coming into the North Fork of the Gunnison from Paonia Dam to the mouth of the river. Therefore, the shorter the distance to the dam, the lower will be the flow. To take advantage of the higher downstream flows for immediate dilution of the pulp mill wastes and to avoid discharge of wastes to the Paonia Reservoir, the best pulp mill site in the stretch from Somerset to Hotchkiss from the standpoint of water pollution would be as close to Hotchkiss as possible.

Although the saturation value for dissolved oxygen is approximately 7. 5 p. p. m. , the available basic data indicate that only about 7.0 p.p.m. is present. It is probable that the sewage from Paonia and Hotchliss has an effect. The river system down to Delta is expected to have excellent reaeration characteristics.

At Hotchkiss the North Fork of the Gunnison could support a maximum discharge of 3, 500 pounds per day of 5-day, 20°C. biochemical oxygen demand. This would be equivalent to a 700 ton per day groundwood pulp mill, assuming a well-operated, modern plant. Any bleaching of the pulp would tend to reduce the maximum capacity that may be used.

BIBLIOGRAPHY

1. Sewage and Trade Waste Effluent Regulations,
   Adopted by the State Board of Health, January 14, 1957.

2. Colorado Revised Statutes Annotated, 1953.
   Chapter 62-5-13 to Chapter 62-5-18.

3. A Stream Survey in the Uranium Mining and Milling Area of
   the Colorado Plateau, James M. Morgan, Jr.
   Department of Sanitary Engineering and Water Resources,
   John Hopkins University, December, 1959.

4. Pulp Manufacturing Information, PP-89,
   Forest Products Laboratory, U. S. Department of Agriculture,
   Madison 5, Wisconsin, November, 1958.

5. Water Requirements for Oil Shale 1960-1975,
   Cameron and Jones, Incorporated, Consulting Engineers,
   Denver, Colorado, July, 1959.

6. Private Communication, B. P. Bellport,
   Bureau of Reclamation, Denver, Colorado.

APPENDIX

A draft of the report was submitted to the cooperating agencies for review and comment. The Colorado Department of Public Health and the Colorado Water Conservation Board had no official comments. Comments submitted by the other agencies are presented in full.

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, U. S. FOREST SERVICE:

"The report entitled 'Report on the Waste Disposal Aspects of Potential Pulpmills in Western Colorado' has been reviewed by the Forest Service.

"The consensus of our reviewers is that few comments are required from us on this report since the authors have capably and clearly answered the questions asked them. Our major criterion for evaluating the report was revealed by the nature of the questions asked by us in the basic plan of study. We wanted to know the limitations imposed upon pulpmill capacity in our study area by the pollution aspects of such development. Your agency has very pointedly answered this question with respect to the several sites and processes considered and has thus provided us with important benchmarks of timber resource development within a framework of multiple resource use. We are also pleased with the layout and discussion of basic data and assumptions, the notations that sites other than those studied might well be available, and with the statement that additional evaluations must be made in the face of actual establishment of a pulpmill.

"We would, however, like comment on one point raised during review. Concern was expressed about the lack of discussion of present use of streams in the study area for waste disposal. Any attempt to evaluate resource development opportunities within a multiple resource use context is certain to raise a question as to how much the present use of one resource impinges upon the potential use of another. Although it was presumably necessary for your analyst to deduct current waste loads from assimilative capacities of the streams in order to make his calculations, it was suggested that the manuscript could be strenghtened by pointing out the opportunities, if any, to improve sewage treatment facilities and the resulting effects upon water quality and pulpmill capacity.

"In closing, I would like to thank you for your spirited and productive response to our request for assistance in our pulpmill project. This opportunity is taken also to announce that pending receipt of the final report by your agency and publication of the results of our study of pulpmill opportunities in the study area, the study of the water aspects of pulpmill development is now complete. Other cooperators will be notified by copy of this letter. All cooperators will be given an opportunity to review drafts of the contemplated report when the remaining studies of other aspects of pulpmill development are completed."

COLORADO DEPARTMENT OF EMPLOYMENT, RESOURCES AND COMMUNITY DEVELOPMENT:

"Thank you very much for the 'Report on the Waste Disposal Aspects of Potential Pulp Mills in Western Colorado.'

"As a lay person I think the report is easily read and that it should prove of assistance in identifying the river capacity of various sites for handling the pulp plant effluents.

"I only have one question to raise and this is a matter of judgment. Is the selection of the lowest week flow in a ten-year period on the Colorado River or a twenty-year period on other streams entirely reasonable in the determination of the plant capacity of the treatment facilities required? If any factor other than the public health were involved, it would seem to me, this would be a very arbitrary determination, and since it would seem that plant outputs could be adjusted to stream flows during such minimum flow periods, isn't such a decision somewhat arbitrary even in public health matters?

"This question is admittedly raised from a point of view of the impact on industrial

development and from one not expert in health matters. I would, however, appreciate Mr. Pahren's and perhaps your viewpoint.

"Thanks again for the information. I will be looking forward to receiving a copy of the final report."

COLORADO GAME AND FISH DEPARTMENT:

"The following comments are based upon the Report on the Waste Disposal Aspects of Potential Pulp Mills in Western Colorado by the U. S. Public Health Service Engineering Center in Cincinnati and correspondence from W. N. Gahr of Colorado Health Service concerning the Crown Zellerbach Corporation proposal:

"1. Location near Kremmling appears to be the worst possible site from a fisheries viewpoint. Total river discharge at Kremmling is much lower than further downstream and subject to severe diurnal and seasonal fluctuations due to trans-mountain diversion and power operations. Therefore, much less flow can be expected to aid in diluting the plant effluent. Proponents of this site may argue that plant wastes can be ponded and fed into the stream during periods of higher flows, but it has been our experience that in spite of good intentions, occasional accidental discharges are almost unavoidable and will result in either severe damage or total destruction to the downstream fishery. In this case, damage or destruction would probably occur to the confluence of the Eagle River, the next major source of water which would dilute the pollution.

"We cannot depend upon State Health Department standards to protect the fisheries if the report from the Taft Sanitary Engineering Center is correct in stating that Health Department standards for B. O. D. can be met by a pulp mill while causing the dissolved oxygen to drop below the minimum level needed to sustain trout and trout foods.

"2. Below Kremmling, the next site studied by the Taft Center was the section between Sweetwater and Dotsero (immediately above the confluence of the Eagle River). This site poses less of a threat to the fisheries than further upstream at Kremmling chiefly because there is a chance that the Shoshone forebay will help some in settling out wastes and the forebay is not presently valued greatly for its fishery. There is a much greater amount of water available at this location, but rather than resulting in better dilution of wastes, the great stream flows may permit a mill with a greater capacity to release a greater volume of effluent, still staying below the B. O. D. standard, but utilizing the entire stream flow to meet it.

"3. The next site downstream under study is located between Newcastle and Rifle. The flow is highest here of all the locations studied. Inasmuch as the Colorado is still a good trout stream through most of this section, a mill would pose a considerable threat to fisheries. Again, these greater average stream flows could help in dilution of pollutants, but more likely will merely permit a greater quantity of effluent to be released without violating the B. O. D. standard. If located in this section, the site should be as far downstream as possible toward Rifle so as to protect a maximum amount of trout water. Industrial pollution entering the river near Rifle has already struck a lethal blow to the trout fishery below the entry point.

"4. The lowest and most westward of the four sections studied as possible mill sites on the mainstem of the Colorado River is between Grand Junction and Fruita. Average flows are less here than in the next study section above due to the heavy diversion of water to the Grand Valley Project. Trout are not a factor in this lowest section, but pollution would take its toll of channel catfish, the only game fish species common to the section. At present, few people fish for the catfish so that if any section of the Colorado River is to be further damaged by pollution from a pulp mill, then the first choice of sites affording the best protection to fish must be the site farthest downstream, completely away from the trout water. The hazards progressively increase upstream.

"The Eagle, White, Gunnison, and North Fork of the Gunnison were also studied as possible mill sites, but as mentioned in the Taft Center report, these streams are so limited in their assimilative capacity that only a groundwood process mill would be practical on these streams. Crown Zellerbach officials have indicated their process would be 20 to 25 percent chemical, so it is highly unlikely that they, or any similar concern, will locate on a tributary.

"Also, there is now a proposal that the pulp mill locate below Denver on the South Platte if Denver can 'acquire' the 100,000 acre feet of uncommitted Green Mountain Reservoir water which Senate Document 80 originally set up for future expansion of the western slope economy. Undoubtedly, this would benefit the fisheries by placing the mill in a location already so badly polluted from many sources that no game fish can survive.

"As a trout stream, the Colorado has already suffered severe damage from storage and diversion projects. Location of a pulp mill anywhere from Kremmling to Rifle will spell the end to trout from the plant on downstream. Even if the plant wastes are carefully treated and handled so as to maintain a dissolved oxygen level high enough to support trout, other factors such as odors, discoloration of the water, and mats of fiber and algae will discourage both fish and fisherman."